Space Weather Technical Forecast

Issued on Tuesday 1 October 2024 at 13:13 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: M-class flares (R1-R2 Blackouts) likely throughout. Chance of G1-G2/Minor-Moderate Geomagnetic storms.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Activity is Moderate, with a long period M7.6 flare peaking at 30/2358 UTC, originating from AR3842 in the southeast quadrant. Moderate activity is likely to continue with further M-class flares probable. These most likely from AR3842, which also gives a chance of an isolated X-class flare.

A couple of CMEs observed leaving the Sun 29/0612UTC and 30/1545UTC may give glancing blows over the next few days, but confidence in detail is very low.

Solar Wind / Geomagnetic Activity: Solar wind parameters were indicative of a weak coronal hole fast wind. Slightly elevated through the period though they have eased back from around 460 km/s to near 420 km/s. Density was at mostly below average values. Interplanetary Magnetic Field, Bt, remianed at background levels - below 8nT. The north-south component Bz, remained at weak values below +/-7nT. Phi angle was negative (towards the Sun). Geomagnetic activity was at Quiet to unsettled levels (Kp1-3).

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux observed by GOES18 was at background levels. High energy electron flux (greater than 2MeV) observed by GOES16 was at background to moderate levels (at diurnal peak), with a peak value of 212 pfu at 30/1750 UTC. The associated 24-hour fluence was below the Active threshold. The 01/0000 UTC observation was 4.38e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate activity is likelt to continue, with further M-class flares. There is a chance of isolated X-class flares, mostly originating from AR3842, located in the southeast.

Solar Wind / Geomagnetic Activity: A CME which left the Sun from the southwest quadrant on 29/0544 UTC has been reanalysed with possible glancing impacts at Earth until early on 02 Oct. A further CME which left the Sun around 30/1545 UTC may give a glancing blow early on day 3 (03 Oct), both of these CME arrivals are low confidence with impact probably weak. Without any CME influences Solar winds are likely to return to background levels over the next couple of days.

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Quiet (Kp 1-2) geomagnetic conditions are expected, with a chance of Unsettled to Active (Kp 3-4) intervals due to the waning coronal hole fast wind environment. There is then a chance of G1-G2/Minor-Moderate geomagnetic storms occurring due to the glancing arrival of the 29 Sep CME, this risk continuing but reducing into day 3 (03 Oct). Confidence becomes lower by day 4 (04 Oct) due to the number of filaments currently on the disc and uncertainty regarding CME arrival times.

Energetic Particles / Solar Radiation: High energy proton flux at GOES18 is forecast to persist at background. High energy electron flux at GOES16 is expected to persist at Background to Moderate levels with a chance of High levels at diurnal peak. The associated 24 hour fluence is expected to initially remain below the Active threshold (1e8 total pfu), though with increasing uncertainty.

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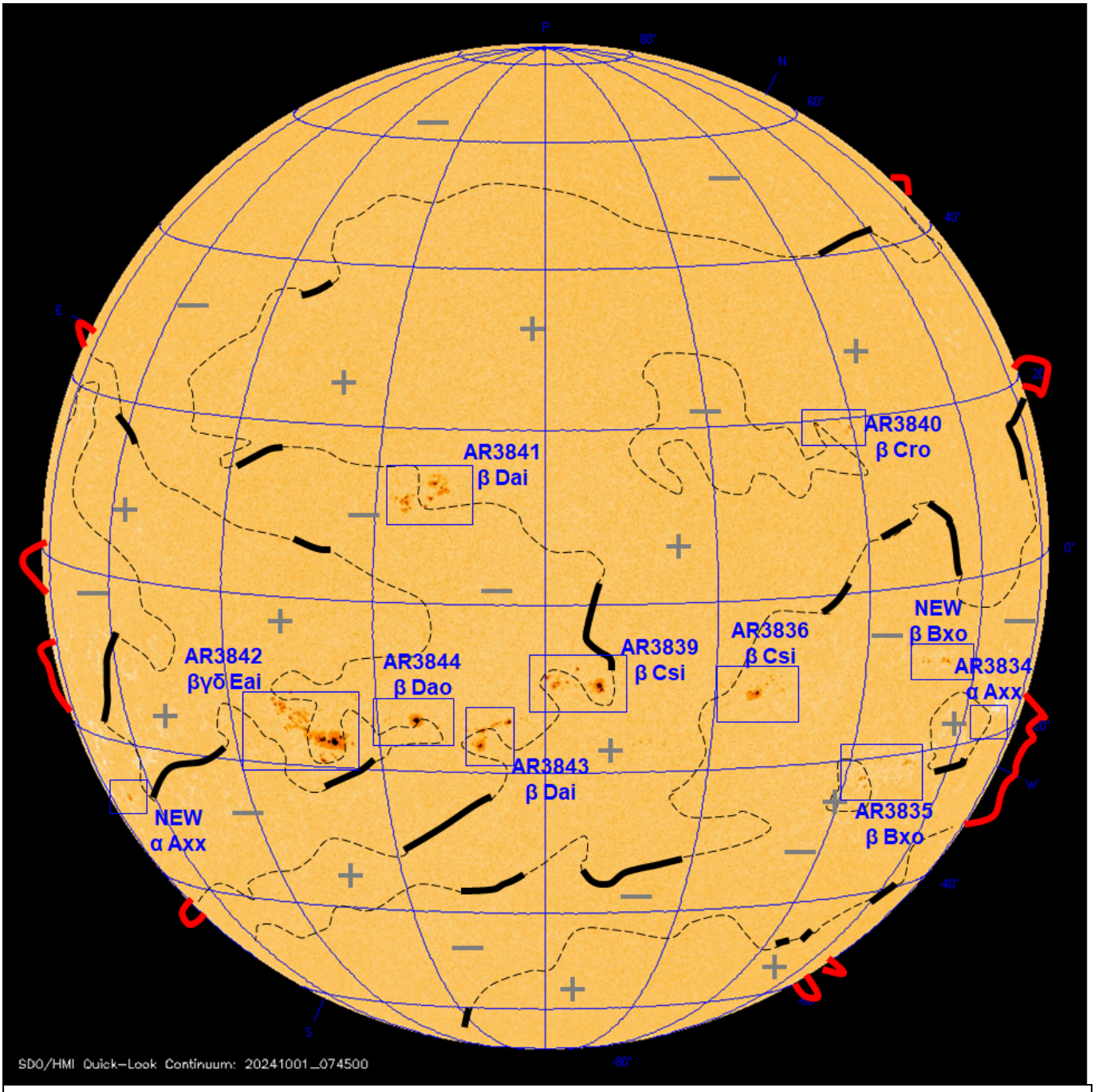
Figure 1: Solar Synoptic Map Valid 0800UTC, 01-10-2024



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

A CME which left the Sun from the southwest quadrant on 29/0544 UTC has been reanalysed with possible glancing impacts at Earth until early day 2 (02 Oct), but with low confidence in the speed due to lack of STEREO A imagery meaning that this CME may be slower than anticipated, perhaps with delayed effects starting on day 2 (02 Oct). Although the bulk of the CME will miss ahead of Earth's orbit, glancing impacts are now considered possible. A further CME was observed leaving the Sun around 30/1545 UTC, this fast CME will mostly miss Earth however there is a small chance of a glancing blow on day 3 (03 Oct).

Solar wind speeds have been at slightly elevated levels through the period, though have eased back from around 460km/s to just above 420km/s as the effects of CH76/- wane. In the absence of any CME, solar wind speeds should trend back to background in the next couple of days. Currently solar winds in MOSWOC Enlil are too high due to Enlil vastly overestimating the longevity of the current coronal hole fast wind. After the recent reanalysis of the 29 Sep CME, MOSWOC Enlil and Enlil ensemble are now displaying an increased risk of a glancing blow from this feature at Earth.

Quiet (Kp 0-2) geomagnetic conditions are expected, with a chance of Unsettled to Active (Kp 3-4) intervals due to the waning coronal hole fast wind environment. There is a chance of G1-G2/Minor-Moderate geomagnetic storms occurring day 1 (01 Oct) due to the glancing arrival of the 29 Sep CME, this risk continuing but reducing into day 3 (03 Oct). Confidence becomes lower by day 4 (04 Oct) due to the number of filaments currently on the disc, as any disruption could result in an Earth-directed CME, and a subsequent increase in geomagnetic activity is possible later in the period.

Geomagnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	30	20	20	10
Strong	G3	No	1	1	1	0
Severe	G4	No	1	1	1	0
Extreme	G5	No	1	1	1	0

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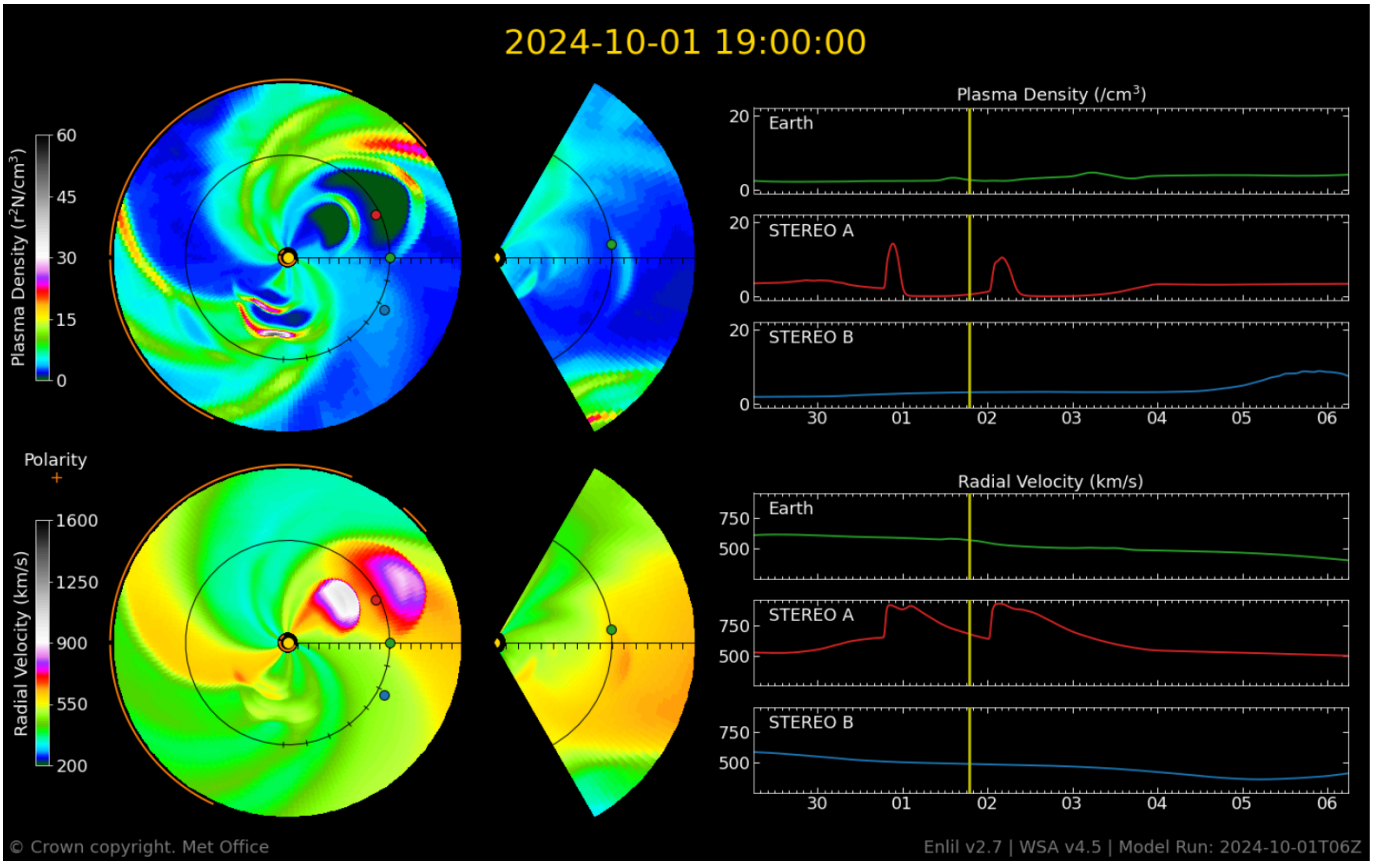
Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R⊙ (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed (km/s)	Estimated Arrival Time (UTC)	Comments
29/0901	Partial	AR3834	SW	1200	01/0900UTC	Glancing blow. Low confidence.
30/1545	Partial	Filament	SW	1500	03/0300UTC	Glancing blow. Low confidence.

Figure 2: MOSWOC Enlil shows a pair of CMEs mostly ahead of Earth but glancing blows are possible.



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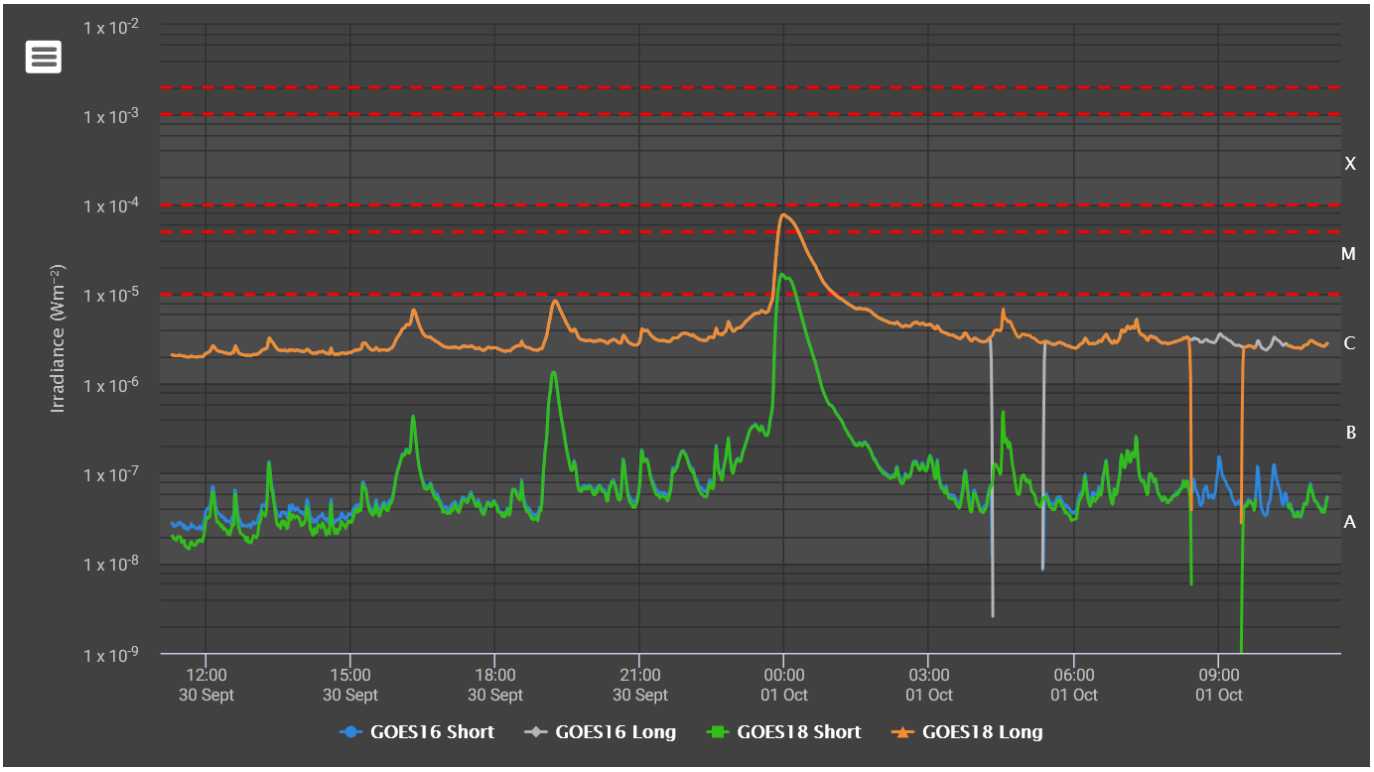
Radio Blackouts - X-Ray Flares

Moderate solar activity is forecast with an ongoing chance of isolated X-class flares. Eleven sunspot regions cover the visible disc. The most notable remains AR3842, the largest sunspot group, and located in the southeast quadrant. This continues to show growth within the intermediate spot structure, now with several spots having joined the main leader. There is one delta region in evidence. AR3841 in the northeast and AR3843 in the southwest are the second largest regions with similar characteristics and have both shown further development in recent hours, mostly in the leading spots. All other spots are smaller and appear relatively benign.

X-Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 (M Class)	Yes	60	60	70	60
Very Active	R3-R5 (X Class)	No	30	20	30	20

Figure 3: Latest X-ray flux plot at GEO from GOES data.



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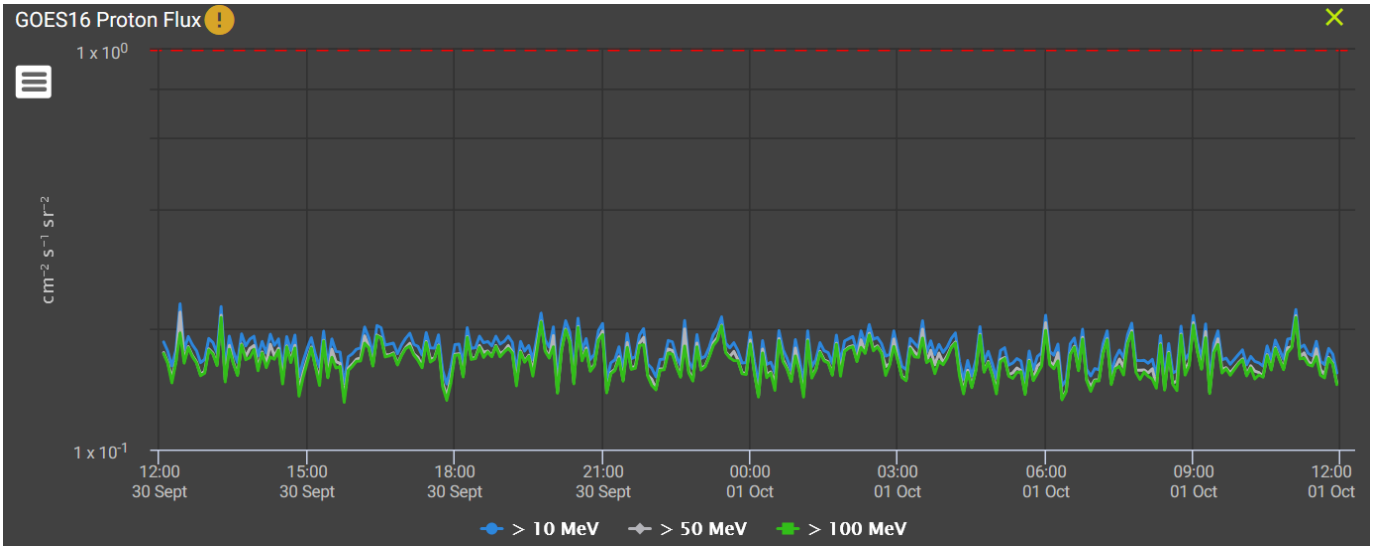
Solar Radiation Storms (High Energy Protons)

High energy proton flux at GOES18 is forecast to persist at background levels. Many of the current visible sunspots are generally small and simple providing only modest contributions to flare risk, and are unlikely to significantly impact proton flux at Earth. However, the chance of Proton rich flares increases as AR3842 rotates closer to centre disk and a more favourable position in coming days. Also, given the number of notable filaments currently on the disc, there is also a very low, albeit non-zero chance of observable protons should any significant filament eruption occur during the period.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	15	15	15
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: GOES16 Proton Flux.



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High Energy Electrons (≥ 2MeV)

High energy electron flux (greater than 2MeV) observed by GOES16 was at background to Moderate levels (at diurnal peak). Electrons are expected to remain at background levels after the recent arrival of a fast wind from CH76/-, which should keep them suppressed in the short-term. A recovery to Moderate or perhaps briefly High levels (at diurnal peak) is likely towards the end of the period.

The associated 24 hour fluence is forecast to stay below Active (1e8 total pfu), in agreement with MOSWOC REFM, although a slight increasing trend is likely towards the end of the period, but is still expected to remain below the Active threshold.

GEO Electron Environment Probability (Exceedance)	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ 1×10^{8}**	No	1	5	10	15
Very Active	**≥ 2 MeV ≥ 1×10^{9}**	No	1	1	1	1

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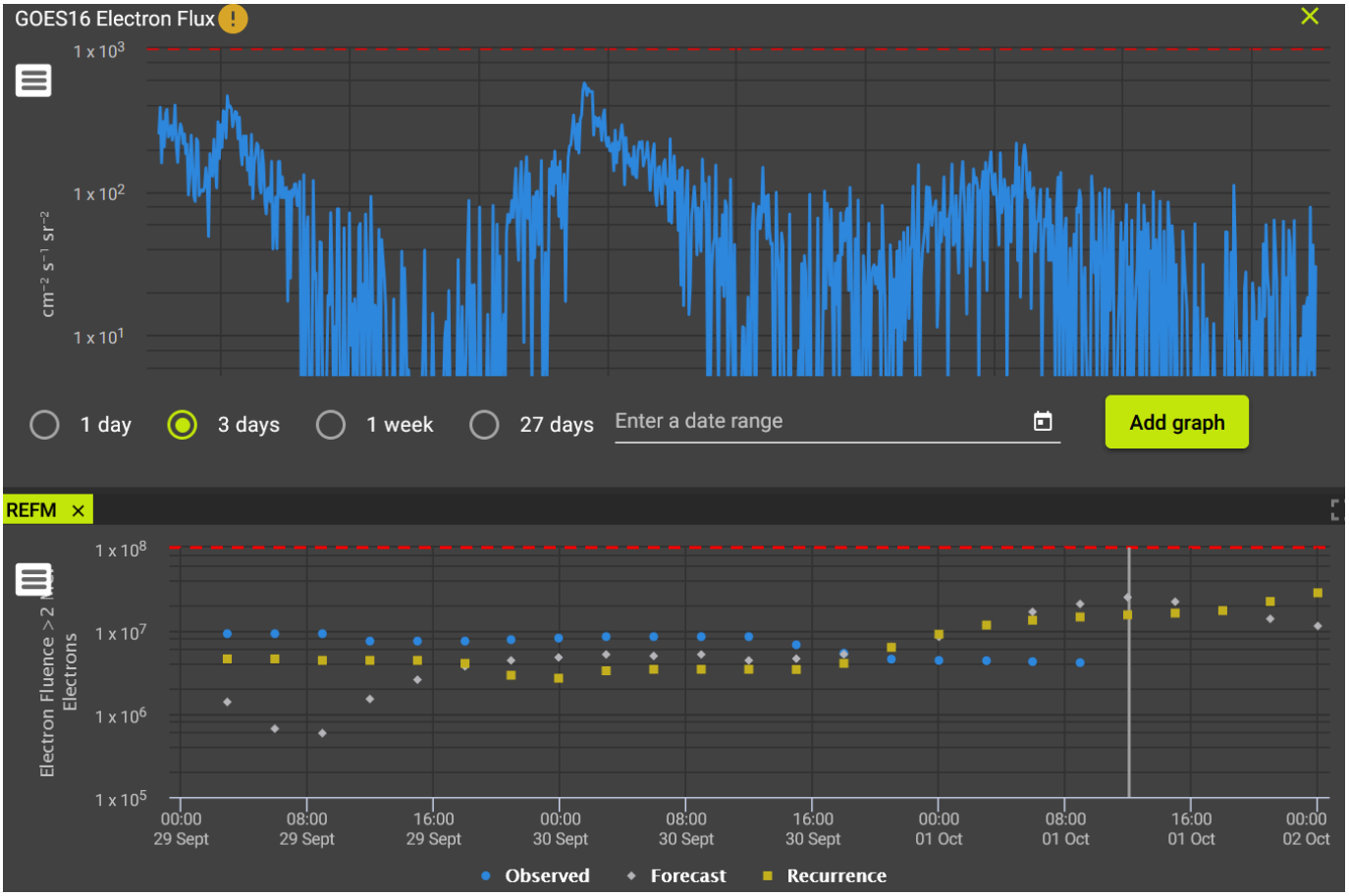
Figure 5: High energy electron flux at GEO and Met Office REFM output guidance.



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